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ALLELOPATHIC EFFECTS OF ANTARCTIC LICHEN AND MOSSES ON THE GROWTH OF ALGAE (EXTENDED ABSTRACT)

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Acetone extracts and aqueous pastes made of fresh and dried materials of Antarctic *Ceratodon purpureus*, *Pottia heimii*, *Grimmia lawiana* and *Usnea sphacelata* showed a remarkable inhibition of algal growth by the ordinary paper disc method described by MCGRATTAN *et al.* (1976) (Table 1). On the inhibitory effects of certain

Table 1. Antialgal activity of Antarctic plants, and their naturally occurring deposits and rookery soil.

Materials	Inhibition zone (mm)			
	Pastes*		Acetone extracts**	
	Mean	S.D.	Mean	S.D.
Lichens				
Usnea sphacelata	3.83	1.65	(0.5)	
Umblicaria aprina	0.4	0.43	(0.5)	
Buellia frigida			(0)	
Unidentified lichen encrusted on *Prasiola*	(0)			
Unidentified lichen encrusted on *Ceratodon*	0.4	0.43		
Mosses				
Pottia heimii	(10.0)***			
Grimmia lawiana	3.0	0.0		
Ceratodon purpureus (Antarctic material)	0.64	0.94	2.2	1.61
Ceratodon purpureus (Japanese material)	0.27	0.21		
Bryum argenteum	(0.5)			
Bryum pseudotriquetrum	0	0	0	0
Naturally occurring algal deposits				
diatomaceous sediments	0	0	1.15	1.65
cyanophytan deposits	0.2	0.22		
phaeophytan deposits			5.6	0.43
rhodophytan peat			0.17	0.24
Rookery soil	(2.0)		0.97	0.54

Results were calculated on the basis of values obtained from 3 replicate samples. (S.D.: standard deviation)
* *ca.* 0.2 g dry weight. ** extracts of *ca.* 0.06 g dry weight. *** indicates weak reaction. ( ) shows a value obtained from a single result. In all cases *Chlorella* sp. was used as the test-alga.

secondary lichen metabolites on the growth of *Chlorella* sp., it was demonstrated that substances such as usnic acid, lichesteric acid and fumarprotocetraric acid possess antialgal activity. Accordingly the principal allelopathic agent of the Antarctic *Usnea sphacelata* is presumably caused by the toxicity of usnic acid which is the main component of those secondary lichen metabolites.

In other experiments, the old culture filtrates of Antarctic *Ceratodon purpureus* also obviously inhibited the growth of *Chlorella*, *Koliella* and *Stichococcus* isolated from Antarctic soils, viz. the algal growth in both the autoclaved and the C18 treated (passed through a lipophilic column made of octadecyl silane) filtrates was evidently better than that of control. This active agent proved to be lipophilic; the inhibitory effect migrates to the chloroform fraction when the extractive solvent of chloroform and methanol mixture was fractionated by addition of water.

In accordance with the previous results, that is long-chain fatty acids have been implicated in allelopathy of algae as well as of angiosperm (PROCTOR, 1957; SCUTT, 1964; MCGRATTAN *et al.*, 1976; MCCRACKEN *et al.*, 1980; ALSAADAWI *et al.*, 1983), we tried a preliminary chemical analysis on *Ceratodon purpureus*, and we could demonstrate several fatty acids ranging in chain-length from 12 to 18 or more carbon atoms in the active extracts of chloroform fractions obtained from Antarctic and Japanese materials. There was also some evidence of a relationship between the relative content of fatty acids and the inhibitive activity of each extract (Fig. 1).

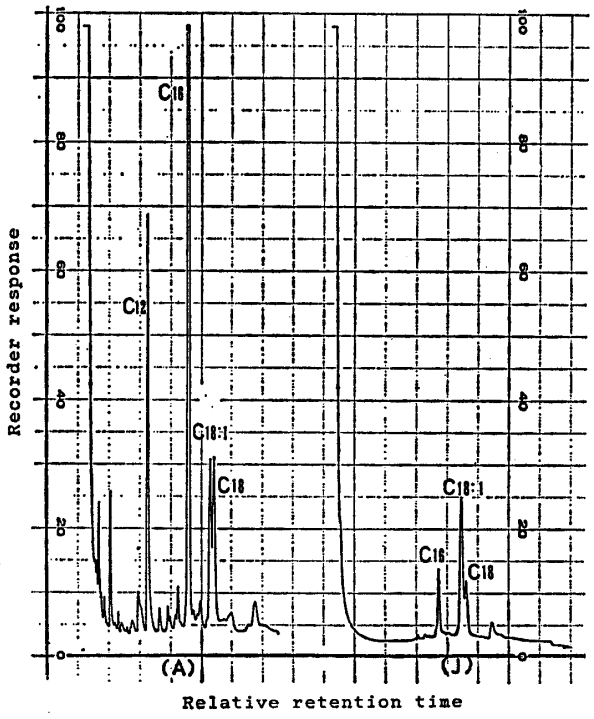

Fig. 1. Comparison of gas liquid chromatographic data of chloroform fraction of extracts obtained from Antarctic (A) and Japanese (J) Ceratodon purpureus *which possessed remarkable antialgal activity (A) and not much effect (J) respectively.*

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